Smartphones and the Internet of Servants

By Peter Corcoran

There is an interesting behind-the-scenes debate going on between a group of senior members of the IEEE Consumer Electronics (CE) Society at the moment. It originated from a subcommittee within the Future Directions initiative and can be summarized by a simple question: "What do we mean by the Internet of Things (IoT)?"

This may seem like a simple question that should have a simple answer, but once you start engaging in active discussions, you'll quickly find that everyone has a different view. Rather than trying to find a silver bullet of a single all-inclusive definition, I thought it might be interesting to take a look at some different perspectives on the IoT and try to explain how these different views originated. In taking this approach, we may hopefully get a better understanding of why the IoT means so many different things to different people, and maybe we can progress to a better understanding of what should differentiate the IoT in a CE context.

WIRELESS SENSOR NETWORKS

Let us start with one perspective that has its origins in what was initially a military concept—that of wireless sensor networks. For the army, the idea of being able to cover a battlefield with smart sensors that could interlink and provide information on the enemy was a powerful idea for a while. But today, they have drones that can do as good a job and are less costly.

The underlying concepts behind these sensor networks quickly made their way into the academic world and spawned, in my opinion, a rather large number of academic publications covering different communications protocols, energy conservation strategies, and coordinated actions across larger populations of devices. Of course, most of this research is theoretical and built on simulations rather than real networks, and very little of it can demonstrate real practical applications. Nevertheless, it is a small conceptual step to connect such networks to a wide area network such as the Internet, which immediately gives you one variant on the IoT.

FROM RFID TO IoT

Here is another way you end up with the IoT—start with a relatively simple identification technology that you can embed in almost anything at a relatively low cost. This is how RFID originally got started. It was a passive technology that did not require any power, but when it was activated, typically by an active antenna, the RFID chip would spit out a short burst of RF energy generating a simple binary code. This became very useful for the large-scale tagging of physical objects and scaled into many supply chain and logistical applications. As a consequence, RFID has become a technology field in its own right. And as the technology evolved from passive to more active implementations, RFID has become capable of more complex functionality that begins to overlap with sensor networks. Bridging RFID via an active

gateway then turns it into another way for things to appear as data sources on the Internet.

EMBEDDED DEVICES AND SYSTEMS

If you are an embedded systems engineer, it's almost certain these days that you have added network connectivity to your system or device. In fact, I recall giving a tutorial at the International Conference on Consumer Electronics (ICCE) back in 2002 on this very topic. The focus back then was on how to implement a TCP/IP stack in 16-bit or even 8-bit embedded systems. These days, it is unusual to find an embedded system that is not at least 32 bit, and TCP/IP support is a given. In fact, wireless 802.11 connectivity is often on-chip as well. Another well-trodden path to the IoT.

CONTROL AND INDUSTRIAL NETWORKS

There are many different types of industry control networks that are widely used. As examples, BACNET is a building automation and control protocol that supports a range of physical network transports and is widely used for heating, ventilation, and lighting control in buildings; Lonworks is a similar building and industry control network technology; DALI is a lighting control network; and the ECHELON protocol is the granddaddy of industrial networking. These are just a few off the top of my head.

Recent IEEE standards (notably IEEE 802.15.4, IEEE 1901, IEEE 1905.1, IEEE 802.21, IEEE 802.11ac,

and IEEE 802.3at) and consortia efforts like nVoy (which verifies IEEE 1905.1 compliance) or QIVICON have provided a standards-based foundation for heterogeneous networking of many devices on many physical networks for diverse purposes. And, as in the case of RFID, when the underlying technologies have matured, there is a natural evolution to full Internet connectivity. Again, linking these control networks to the Internet provides another way to glue on more things to the Internet.

BIG DATA AND SEMANTIC WEB

If you are more a computer scientist than an engineer, your interests lie with processing data rather than the underlying things that might act as data sources. But even the big data people have realized that networks of sensors or even simple RFID chips can be powerful real-time data sources, and some researchers that I know have coined a catch phrase for many of their big data research projects: "The Internet of Things—making Semantic Web and big data 'real'!" So you don't have to be an engineer to get on the IoT bandwagon.

THE INTERNET OF "USER INTERFACES"

Different people have different perspectives, so it probably doesn't surprise you that I was involved with IoT technology in a past life. My view, which hasn't changed much from that time, was a little different. I took the perspective that the IoT should be about providing a generic means for things to make their functionality available to an end user. After all, if you can't get access to control a thing, it doesn't really count as a CE system. At that time, I was working with CEBus networks and integrating these with the Internet [1], [2].

A key aspect of gluing such local networks to the wide-area Internet is that individual network objects have a local state and this has to be synchronized with an external state of the network that is exposed as a control interface. This requires a separate virtual data structure to provide a memory of the individual device state [3]. Conveniently, this data structure can also be mapped onto a user

interface that is readily accessed through a Web browser [4], [5]. Some more specific examples are given in several later papers where methods to combine multiple user interfaces into a single metadevice are explored [6]–[8]. One nice aspect of this approach is that different control devices can update the state of a metadevice independently as control messages are sent over TCP/IP. No more fighting over the remote control, as any device that is TCP/IP enabled can be the remote control.

WHY IS THIS IMPORTANT?

So we see that there are many different viewpoints as to what the IoT means. Now the IoT is a broadly scoped technology that stretches across the field of interest of nearly all IEEE Societies. As CE people, we need to give some thought to how we should interpret what the IoT means and how it relates to, and links into, CE. This is important as it will also define how the CE Society can add value to this IEEE initiative.

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So you may consider this piece as an attempt to seed discussion and solicit your opinion on what the IoT means in the context of CE. For us as a Society, this is important if we are to differentiate our contribution to the broader IEEE work on this topic. I've presented my rather dated interpretation, but I feel that it still offers a somewhat different and very CE-centric approach compared with the alternatives.

CONCLUDING THOUGHTS

Let us think about this in another way—your home is full of CE gadgets, and, like it or not, these are becoming more connected. There is value for the device manufacturers as they can monitor and gather data on device usage and, in some cases, even offer additional functionality based

on the added network connectivity. And for some applications, value may be added to a manufacturer's appliances by connecting complementary devices together in a more sophisticated way. But does this represent a real benefit for the consumer? Why should I care if my vacuum or toaster is networked? Why would I pay for this functionality, even where the additional cost is marginal?

These are quite challenging questions if you take the conventional machine-to-machine view of the IoT. To draw an analogy, it's a bit like the 19th-century house full of servants—they all perform their own tasks quietly and unobtrusively, but there is a lot of chatter and gossip going on in the background that doesn't really add any value to the individual contributions for the consumer. Finding an application where two or more servants are actually needed to work together is also challenging.

So if machine-to-machine connectivity has limited value in a CE context, where is the argument for the CE IoT? Why do we need that Internet-enabled toaster?

Think smartphone and you have your answer—all of your devices at your fingertips as soon as you enter your home. That is the added value of connected CE devices, and that's where CE people need to put the emphasis. And that's why we should call it the "Internet of User Interfaces"—its not about getting your servants to work better together; Its about empowering them to be more available to you.

IN THIS ISSUE

We have quite a broad range of topics in this Fall issue of *IEEE Consumer Electronics Magazine*. Let us start with our regular articles.

CHAMPIONS OF CE

This group of articles is the first of a new series for *IEEE Consumer Electronics Magazine*. One of the benefits of joining the CE Society is access to senior engineers and researchers from our industry. Many of our members are well known professionally within their own field and have championed some of the many foundation technologies on which our industry relies. There are actually quite a

IT was six men of Indostan
To learning much inclined,
Who went to see the Elephant
(Though all of them were blind),
That each by observation
Might satisfy his mind.

ii.
The First approached the Elephant,
And happening to fall
Against his broad and sturdy side,
At once began to bawl:
"God bless me!—but the Elephant
Is very like a wall!"

iii.
The Second, feeling of the tusk,
Cried: "Ho!—what have we here
So very round and smooth and sharp?
To me 't is mighty clear
This wonder of an Elephant
Is very like a spear!"

iv.
The Third approached the animal,
And happening to take
The squirming trunk within his hands,
Thus boldly up and spake:
    "I see," quoth he, "the Elephant
Is very like a snake!"

v.
The Fourth reached out his eager hand,
And felt about the knee.
"What most this wondrous beast is like

Is mighty plain,"quoth he;
"'T is clear enough the Elephant
Is very like a tree!"

vi.
The Fifth, who chanced to touch the ear,
Said: "E'en the blindest man
Can tell what this resembles most;
Deny the fact who can,
This marvel of an Elephant
Is very like a fan!"

vii.
The Sixth no sooner had begun
About the beast to grope,
Than, seizing on the swinging tail
That fell within his scope,
"I see," quoth he, "the Elephant
Is very like a rope!"

viii.
And so these men of Indostan
Disputed loud and long,
Each in his own opinion
Exceeding stiff and strong,
Though each was partly in the right,
And all were in the wrong!

moral.
So, oft in theologic wars
The disputants, I ween,
Rail on in utter ignorance
Of what each other mean,
And prate about an Elephant
Not one of them has seen!

few of these champions lurking in our midst, and the goal of this series of articles is to introduce you to them.

Our first champion is Kees A. Schouhamer Immink, a former Ibuka Award winner and IEEE Fellow. You can find a detailed bio at the start of our "Champions of CE" article and, in the "Society News" section, you'll see that the University of Johannesburg recently honored Kees for his role in developing the first CD drives. It is fitting, therefore, that our first "Champions of CE" article is "The Story of the Compact Disc."

I expect that this will become a regular feature, as our Society has quite a few senior members who have created many of the technologies that you use on a daily basis in your life. Each of them also has a story to tell about the development and creation of that technology, and I'm going to encourage them in turn to share these stories and experiences with our younger members. This way, if you bump into one of our "Champions" at a conference or workshop, you'll know who they are and, more importantly, why they are involved in the CE Society.

SECURITY AND CE

In this issue, we have two complementary articles. From Simon Crosby, a past keynote speaker at ICCE, and coauthors Gaurav Banga and Ian Pratt, we have the article, "Trustworthy Computing for the Cloud-Mobile Era." This feature provides a detailed and visionary outline of how we can move to secure new CE devices by providing a micro-VM infrastructure that is ready for the continuing development of the cloud and new cloud-computing services. This integrates the cloud into the very fabric of our devices. If you are a regular reader of *IEEE Consumer Electronics Magazine*, you'll know how important cloud computing already is to today's CE devices; so this article is very timely and some may even feel controversial. Please feel free to write to me expressing your opinions.

To complement Simon's article, we have a more down-to-earth article on the practical status for smartphone security. In "Smartphone Security," Slawomir Grzonkowski, Alejandro Mosquera, Lamine Aouad, and Dylan Morss write about some of the day-to-day threats to which we are all increasingly exposed as we use our beloved smartphones. While smartphone threats are still very much in their early stages, there are increasing risks. And these guys should know, as their day job is to fight these threats. This article is the first in a series of related articles that will focus on different mobile operating systems and devices.

ELECTRICITY USE BY CE DEVICES

I often encourage engineers to have an interest in the societal and environmental impacts of their work. One area in particular in which I've had an interest is the impact of consumer devices and technologies on electricity consumption. I wrote initially on this topic a couple of years ago [9] to highlight the increasing contribution to electricity demand by CE devices. Admittedly, a significant portion of that contribution was due to the network infrastructure that is required by newer devices, as was shown in a more detailed study [10].

In this issue, I'm happy to bring a good-news story from Brian Markwalter of the Consumer Electronics Association (CEA). In this "Society News" article, Brian presents a summary of a new study based on 2013 data that provides a detailed overview of the improvements that have been achieved in a very short time frame within the CE industry [11]. In fact, the improvements are so significant that many of today's devices use only a third of the power they used a decade ago. Another trend, because of the explosive growth of smartphones and tablets, is that many home desktop computers have fallen into disuse, leading again to significant reductions in electricity consumption. And, as these new technologies displace the last generation of devices, CE should become more frugal.

WEARABLES AND STANDARDIZATION

In his article, Stephen Kirk of UL, and keynote speaker at ICCE 2014, addresses "The Wearables Revolution: Is Standardization a Help or a Hindrance?"

While wearable technology looks set to drive the next wave of CE innovation, standards are still needed; the question is whether standards might disrupt the disrupters. How should standards bodies approach this rapidly evolving new market, becoming more agile and less of a dampening force to innovation? A number of interesting and topical examples are discussed, and conclusions are reached regarding the balance to be struck in the standardization process.

A BIT OF PHILOSOPHY

Our next article, "How Smart Are Smartphones?," can be viewed as an exploration of the intelligent capabilities of current and next-generation consumer devices, in particular, smartphones, through an investigation of certain propositions and arguments modeled on the famous Chinese room arguments of John Searle [12]. The question to be answered is, naturally, how smart are smartphones? And the answer—well you'll have to read the article for that. Thanks to the

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authors, Angelos Amanatiadis and Savvas A. Chatzichristofis of the University of Thrace, for stretching our minds a bit in the course of this article.

DIGITAL BEAUTY

Today, digital retouching of your pictures is made possible in the latest smartphones and cameras at the touch of a button. What is more, all of this can be achieved transparently to the user, in real time, just as the image is acquired, or added afterwards, allowing users to manipulate and enhance individual faces according to their personal preferences. In this article, we'll take a look at some of these techniques and consider how far today's technology can go with improving how we look. Having started with an insight into today's technology, the authors continue with a future vision that you may find a little disconcerting. But what else would you expect when your trusted editor is involved? The article is authored by Peter Corcoran, IEEE Fellow, Cosmin Stan, Corneliu Florea, IEEE Member, Mihai Ciuc, and Petronel Bigioi, IEEE Senior Member.

IMPACTS OF CE

As engineers working in the field of CE, we are the electronic architects of tomorrow. But the scope and scale of impact that our designs and architectures can have on society and the economy places a significant responsibility on our shoulders. CE isn't just about the design and manufacture of electronic systems and products. These devices and their ecosystems have been changing and altering our lives since the introduction of the TV set in the 1950s and 1960s. Today, their impacts are felt on a global scale not only in the developed world but increasingly among those in the developing world.

This is the second issue where we feature a new cross-disciplinary section, aptly titled "Impacts" and launched this issue in collaboration with *IEEE Technology and Society Magazine*. The "Impacts" section is introduced to help facilitate a broadening of our perspective on the world of CE and to learn more of the various impacts of CE on society. It is introduced in partnership with the IEEE Society on Social Implications of Technology (SSIT).

TECHNOLOGY AND THE ELDERLY

In the article "Factors Influencing the Acceptance of Technology by Older People," the authors, T.M. Raymundo and C.S. Santana, present a recent research study. This study aims to analyze the acceptance of technology by the elderly and the variables that influence the acceptance and insertion of these technological devices into everyday life. It is a transversal, qualitative–quantitative, and analytical study. The procedures of data collection included a socioeconomic questionnaire, an instrumental activity of daily living scale, an acceptance of technologies scale, and a questionnaire with a focus on the factors that influence the use of technologies.

THE DARK SIDE OF SOCIAL MEDIA

In our second article of this issue's "Impacts" section, we have an interesting, and even provocative, discussion from Ying-Chiang Cho in "Violence and Aberration in the Age of Social Media." This fascinating article explores some negative aspects of the Internet as it continues to embed itself more deeply in our lives. Phenomena such as the Arab Spring may lead us to see the use of new social media tools, such as Twitter and Facebook, as powerful tools supporting personal freedom and democracy.

However, the truth is not so simple, and with freedom comes responsibility. A more detailed consideration shows that these benefits can be short-lived and, more importantly, are easily abused. Not only can the Internet provide a means to greatly amplify undesirable behaviors, such as school bullying, which led to the rise of the recent and global phenomenon cyber-bullying, but it can also facilitate infidelity, challenging the integrity of the family unit, and has even found use as a tool to coordinate and organize full-scale riots as was seen in recent years in the United Kingdom. Each of these troubling social impacts are discussed, and a range of case studies are presented to support each of these.

CE NEWS AND EVENTS

I'm writing this issue's editorial from Ottawa, the capital of Canada, where our Board of Governors is currently meeting. One of the largest and most active CE Society Chapters outside of the United States is based in Ottawa, and we had a Chapter meeting the day following our face-to-face board meeting. I've invited some articles from our Canadian colleagues to show how local activities are run and organized here, which I hope to feature in the next issue. I'd like to try and get more stories from such local Chapters to better understand and share with our members what makes a Chapter successful and sustainable. So, if you want to write about your local CE Society activities and events, please feel free to contact me.

Now back to our regular news section with stories from our local Chapters, conference reports, and a range of other topical and newsworthy stories.

Among our stories, this issue, our "Champion of CE," Kees Immink, was honored by the University of Johannesburg. We also have an introduction to a new CE standard for electronic repair manuals and the announcement of a major industry report on the electricity use of CE devices commissioned by the CEA. Each of these stories has connections to active members within the CE Society, and if you know of other interesting news items with which some of our members are involved, please send me the details for inclusion in future issues of *IEEE Consumer Electronics Magazine.* It is important to share and recognize the achievements of our colleagues, and the best recognition is from your peers.

This issue also features an overview of the 2014 International Symposium on Consumer Electronics, held on the beautiful tropical island of Jeju, and a report from our largest CE Chapter, in the Santa Clara Valley, that has recently celebrated its 10th anniversary. As our main ICCE 2015 conference approaches, I've included a pictorial article reminding us of the work that goes on behind the scenes every year to support the many CE Society conferences and events that our members can now enjoy and from which they benefit.

If you've been a CE Society member for a while, you might consider standing for a position on our Board of Governors to help contribute more actively to the running and operation of your Society. It is also a good place to make new contacts and friends.

REGULAR COLUMNS

IP CORNER

In this issue, we take a look at the problem of patenting complex CE devices or technologies. In particular, we take a look at the work of our CE champion, Kees Immink, and some of the key patents he contributed to help protect the original compact disc players. We'll see how a range of different aspects of the underlying technology were covered by a handful of key patents, each directed to a different aspect.

BITS VERSUS ELECTRONS

Bob Frankston provides some of the most thoughtful and insight-laden commentary on how things are and how they should be. His column is one of my favorite parts of *IEEE Consumer Electronics Magazine* because he so readily integrates the broader socioeconomic perspectives with a strong understanding of the underlying technology.

In this column, Bob discusses "Connected Things"; he muses on many of the challenges to provide the infrastructure needed to make the IoT work the way people will expect. Both Bob and myself are part of the IoT Future Directions Working Group within the CE Society, and if you are at one of our conferences this year, you may see us in a panel session discussing our thoughts and views on the IoT.

THE ART OF STORAGE

In this issue, Tom Coughlin takes a look at data centers and how they are becoming an increasingly important source of new cloud-based consumer services. These remote services provide capabilities that low-cost and low-power consumer products cannot provide. Tom considers both the wider availability of commercial multimedia content and also the rapid growth of consumer-generated content. As always, it is an interesting and insightful perspective on this topic. Thanks Tom!

PRODUCT REVIEWS

In this issue, we have many great product reviews from William Lumpkins, one of our senior editors. The first topic deals with a problem experienced by many of us: how do we power our mobile devices throughout the working day? Most smartphones find it challenging to get through a standard 8–10-h working day. Will considers some options and gives his thoughts and recommendations. He also provides a review of the Neato robot vacuum cleaner. What is interesting is that the Neato vacuum features the same underlying technology as Google's driverless car. Will has challenged the Neato with some difficult test environments. Read on and enjoy his insights and commentary on this interesting high-tech device.

CALLS FOR ARTICLES

INTERNET OF THINGS

The IoT refers to uniquely identifiable objects and their virtual representations in an Internet-like structure. The term "Internet of Things" was first proposed by Kevin Ashton in 1999 [6], although the concept has been discussed in the literature since at least 1991 [7] and in the context of CE and home networking since 1996 [8]–[10]. Today, research into the IoT remains in its infancy. For this call,

our principal theme is focused on how the IoT will integrate with, change, and disrupt different sectors of the CE industry.

A special issue is planned for the January 2015 issue of *IEEE Consumer Electronics Magazine* to coincide with the 2015 International CES and the editor would like to encourage readers to submit relevant articles. A detailed call will be found later in this issue.

SOCIETAL IMPACTS OF CONSUMER ELECTRONICS

Following the launch of a special section of *IEEE Consumer Electronics Magazine,* aptly titled "Impacts," from July 2014, a call for articles is announced and will continue on a rolling basis. Articles are sought that facilitate a broadening of our perspective on the world of CE and our understanding of the various impacts of CE on society. This special section is introduced in partnership with the IEEE SSIT.

This is a continuous call for content for the "Impacts" section of *IEEE Consumer Electronics Magazine*, and further details can be found in the full call for articles that follows later in this issue.

CONCLUDING COMMENT— LEADERSHIP TRANSITIONS

This is another successful issue of *IEEE Consumer Electronics Magazine* as we see the continued evidence of growth in content and scope. But there is one slightly sad aspect as we feature the last "President's Message" column from Stefan Mozar. Stefan will, unfortunately,

not be standing for a second term as president as he has been nominated for the position of Region 10 director and our revised Society bylaws preclude him standing for both positions.

In many ways, this is a great loss for the CE Society as Stefan has been responsible for many of the new conferences to which CE Society members now have access, and he has also been pivotal in the initial establishment of the Technical Activities Board case for *IEEE Consumer Electronics Magazine* and many regional development activities and events. His two years as CE Society president were the natural culmination of more than a decade of hard work behind the scenes.

However, his achievements and successes within the CE Society have been noted by IEEE headquarters, and it's a great recognition for Stefan to be nominated for this major IEEE leadership role. Naturally, he will continue to serve and advise the CE Society in 2015 as past president, and I do hope that he will also continue to be actively involved as in the past. I would like to take this opportunity to personally wish him well with new challenges and success as a senior IEEE leader.

I'll also take this opportunity to briefly introduce and welcome our incoming president, Sharon Peng, and incoming vice president of operations, Brian Markwalter. Both have senior roles in their respective organizations and are seasoned veterans of the CE industry. We will have a detailed feature with biographical sketches for both Sharon and Brian in our

next issue. Special congratulations are due to Sharon as the first woman president of the CE Society. I expect she will bring some interesting new perspectives and strategies to help build on recent successes. It looks like 2015 is shaping up to be an interesting year for the CE Society.

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